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Issued February 10, 1913.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—Circular No. 105.

B. T. GALLOWAY, Chief of Bureau.

# EXPERIMENTS IN THE CONTROL OF GRAPE ANTHRACNOSE.

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65010°—13

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1913

WITHDRAWN FOR EXCHANGE-A. M. L

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[Cir. 105]

# EXPERIMENTS IN THE CONTROL OF GRAPE ANTHRACNOSE.

## INTRODUCTION.

Anthracnose of the grape, or bird's-eye rot, caused by the fungus *Sphaceloma ampelinum* De Bary, is a disease of considerable importance on certain varieties of grapes grown in the eastern United States. While the disease does not seem to attack the Concord, which is the most extensively grown of American varieties of grapes, Vergennes, Salem, Diamond (*Moore's Diamond*), Norton (*Norton's Virginia*), Missouri Riesling, Diogenes, Champion, and other varieties of both wine and table grapes are very susceptible to anthracnose. In serious outbreaks of the disease the fruit in a vineyard of one of these susceptible varieties may be almost entirely destroyed and the vines seriously damaged. Certain exceptionally fine varieties of wine and table grapes can not be grown successfully in some localities because of unusual susceptibility to it.

Anthracnose affects practically all the green parts of the plant. On the green shoots it causes cankers (Pl. I, fig. 3), which first appear as small, light-brown, slightly sunken spots. These spots enlarge, sink deeper, and become darker in color as the disease progresses. If the canker is near the base of a shoot, the whole shoot may be killed. If not killed directly by the disease, the shoot may be so weakened as to be easily broken. The fungus causes cankers on the petioles and ribs of the leaves (Pl. I, fig. 2), on the stems of bunches of grapes, and on the tendrils. On the grape berries it first appears as light-brown spots, which rapidly become darker and are soon surrounded by a circular bright-red zone, which, as seen against the green background of the grape, presents the very striking appearance that gives the disease the name of "bird's-eye rot." The berries in later stages of the disease shrivel and dry up (Pl. I, fig. 1).

The fungus is also reported to be the cause of a leaf-spot. The writer has, however, never observed any case of leaf-spot on grape leaves that could be attributed to it. The fungus is supposed to live over the winter in the old wood and in mummied grapes. It reproduces itself by means of minute, oblong, colorless spores, which infect the young, green parts of the plant. The disease is well known in Europe and, according to reports, may be controlled by proper treatment. Very little has been done in America, however, toward working out the best method for preventing the disease, and the recommendations for its treatment in this country are usually based on its treatment abroad. As the climatic conditions of American and European vineyards differ, as well as the varieties of grapes usually grown in them, it was thought that it might be necessary to modify the treatment of the disease as practiced in Europe, in order to adapt it to American vineyards. The experiments described in this circular were accordingly taken up by the writer, under the direction of Dr. C. L. Shear, Pathologist, of this Bureau, to see whether the disease could be controlled in this country by the use of a solution of iron sulphate and sulphuric acid in water, which is employed extensively in Europe. It was also considered worth while to experiment with applications of other fungicides to the dormant vines and to try the effect of summer sprays in comparison with the iron-sulphate and sulphuric-acid treatment mentioned.

## EXPERIMENTATION.

The experiments which are here reported were conducted at Lawton, Mich., in a vineyard of Champion grapes belonging to Mr. John Robinson. In this vineyard in 1909 about two-thirds of the fruit had been destroyed and the young wood seriously injured by anthracnose. The vines selected for experimentation were a block of about 600 where the disease had been the most severe. This block was divided into nine plats, seven of which were to be treated and two to remain untreated as controls. The order in which the treated plats and controls were arranged is shown in Table I.

TABLE I.—*Treatment given plats of grapevines at Lawton, Mich., in 1910, 1911, and 1912 and the results obtained in 1911 and 1912.*

| No. of plat. | Treatment in 1910. | Treatment in 1911. | Diseased fruit in 1911. | Treatment in 1912. | Diseased fruit in 1912. |
|---|---|---|---|---|---|
| | | | *Per cent.* | | *Per cent.* |
| 1 | (When dormant.) Iron-sulphate mixture No. 1. | Same as in 1910 | | Same as in 1910 | |
| 2 | (When dormant.) Iron-sulphate mixture No. 2. | Same as in 1910 | | Same as in 1910 | |
| 3 | Control, untreated | Control, untreated | 32.6 | Control, untreated | 10 |
| 4 | (When dormant.) Ten per cent solution of sulphuric acid. | 4 per cent solution of sulphuric acid. | | Same as in 1911 | |
| 5 | (When dormant.) Concentrated lime-sulphur solution (1–10). | Same as in 1910 | | Same as in 1910 | |
| 6 | | Control, untreated | 12.2 | Sprayed 5 times with 4–3–50 Bordeaux mixture. Two pounds of rosin-fish-oil soap were added in the last two applications. | |
| 7 | | Self-boiled lime-sulphur solution (8–8–50); four applications. | | do | |
| 8 | | 4–3–50 Bordeaux mixture; four applications. | | do | |
| 9 | | 4–3–50 Bordeaux mixture with two pounds of rosin-fishoil soap to 50 gallons of mixture; four applications. | | do | |

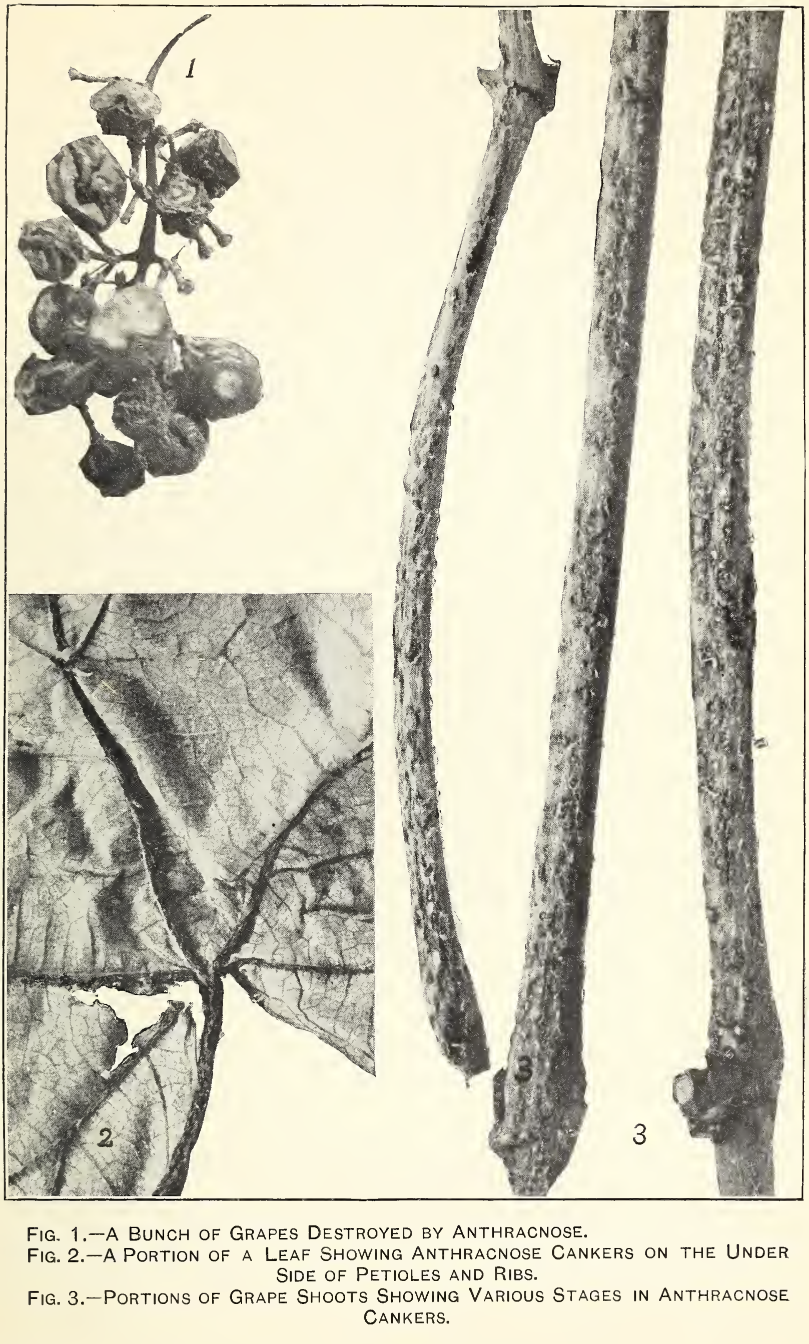

Fig. 1.—A Bunch of Grapes Destroyed by Anthracnose.

Fig. 2.—A Portion of a Leaf Showing Anthracnose Cankers on the Under Side of Petioles and Ribs.

Fig. 3.—Portions of Grape Shoots Showing Various Stages in Anthracnose Cankers.

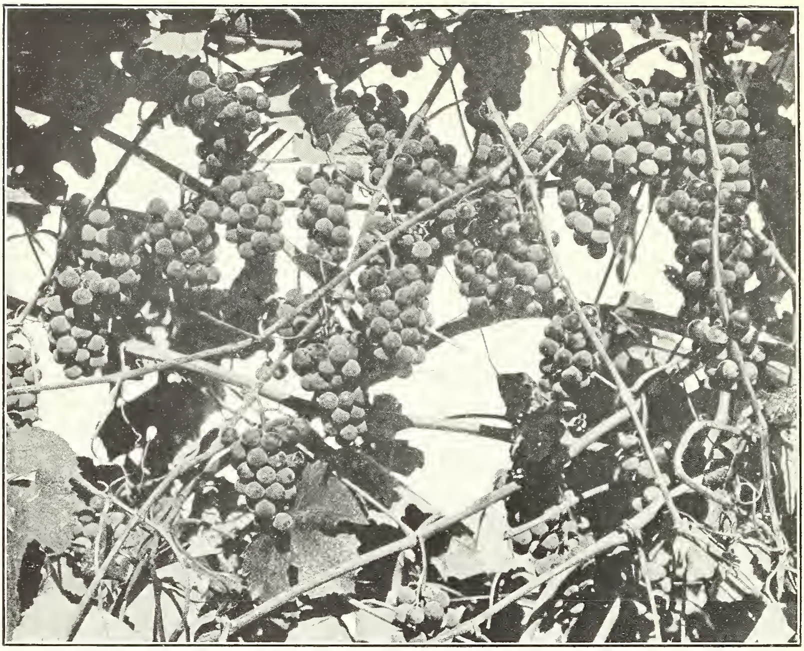

FIG. 1.—A PORTION OF AN AVERAGE VINE WITH SOME LEAVES REMOVED, SHOWING THE CONDITION OF FRUIT ON THE TREATED PORTION OF THE VINEYARD IN 1912.

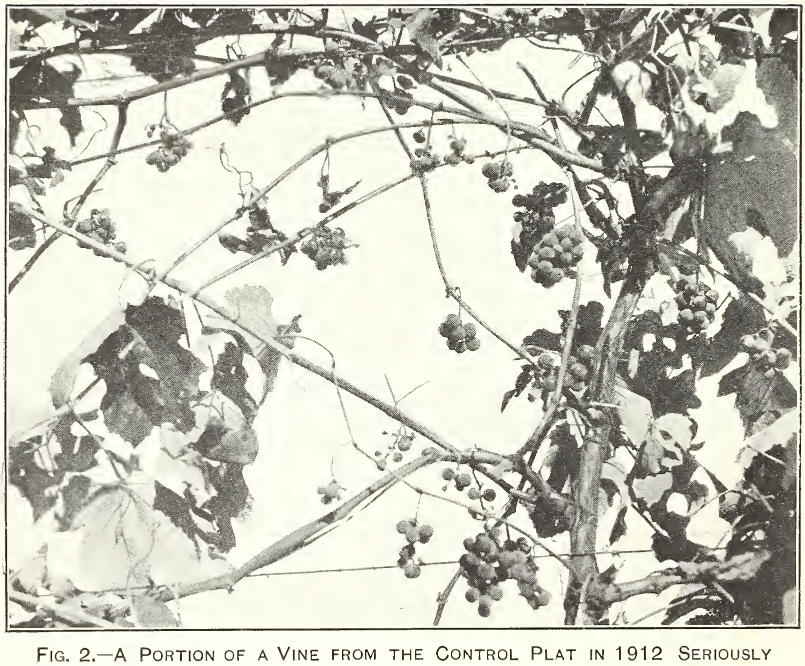

FIG. 2.—A PORTION OF A VINE FROM THE CONTROL PLAT IN 1912 SERIOUSLY DAMAGED BY ANTHRACNOSE, ABOUT THE SAME NUMBER OF BUNCHES BEING SHOWN AS IN FIGURE 1.

The following fungicides were tested in the experiments:

(1) Iron sulphate, 13¾ pounds; sulphuric acid (commercial), 7 ounces; hot water, 3¼ gallons.

(2) Iron sulphate, 6⅞ pounds; sulphuric acid (commercial), 3½ ounces; hot water, 3¼ gallons.

(3) Sulphuric acid (commercial), 10 per cent solution.

(4) Sulphuric acid (commercial), 4 per cent solution.

(5) Commercial lime-sulphur solution (1–10).

(6) Self-boiled lime-sulphur solution (8–8–50).

(7) Bordeaux mixture (4–3–50).

(8) Bordeaux mixture (4–3–50) with 2 pounds of rosin-fishoil soap added.

The mixtures were prepared as follows:

For the iron-sulphate mixtures the required amount of crystallized iron sulphate was placed in a wooden tub and treated with the proper quantity of sulphuric acid. The boiling water was then added and the mixture stirred until the iron sulphate was all in solution. The mixture was used immediately after preparation.

The sulphuric-acid solutions were made by adding the requisite quantities of the acid to the water in a wooden tub and stirring.

The concentrated lime-sulphur solution was prepared by mixing 1 gallon of commercial lime-sulphur solution, 32.8° Baumé, with 9 gallons of water.

The self-boiled lime-sulphur mixture was prepared as recommended by Scott.[1]

The Bordeaux mixture and the Bordeaux mixture with soap added were made in the usual way.

Mixtures Nos. 6, 7, and 8 were used only as summer sprays, while the others were applied only to the dormant vines.

The vines in all the plats were pruned carefully each season during which the experiment was in progress. All the canes on which the disease could be readily recognized were cut away, and the prunings, together with the dead leaves and other débris, were removed from the vineyard and burned.

Plats Nos. 1, 2, 4, and 5 were treated before the buds opened, as shown in Table I. In applying the mixtures to these plats it was considered inadvisable to use a sprayer, because of the effect of the sulphuric acid in mixtures Nos. 1, 2, 3, and 4 on the brass and iron parts of the spray pump. Several methods were tried in applying the mixtures, the best results being obtained by using common whitewash brushes provided with short handles. With these brushes the vines of plats Nos. 1, 2, 4, and 5 were thoroughly washed with the fungicide. The summer sprays were applied with a traction sprayer.

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[1] Scott, W. M. Lime-sulphur mixtures for the summer spraying of orchards. Circular 27, Bureau of Plant Industry, U. S. Dept. of Agriculture. 1909.

In the spring of 1910 after the fungicide had been applied to plats Nos. 1, 2, 4, and 5, a series of late frosts killed back the young growth three different times. As this practically eliminated all possibility of fruit for the season, the experiments were discontinued for the year. The experiments were continued in 1911, as had been planned. Plats Nos. 1, 2, 4, and 5 were treated while the vines were dormant, as in 1910, except that a 4 per cent instead of a 10 per cent solution of sulphuric acid was used on plat No. 4. The stronger solution seemed to injure some of the buds. Plats Nos. 7, 8, and 9 were thoroughly sprayed four times—once before the blossom, a second application immediately after the blossom, and the other two applications at intervals of two weeks.

The treatment of the dormant vines on plats Nos. 1, 2, 4, and 5 was continued in 1912 as in 1911. Plats Nos. 6, 7, 8, and 9, however, all received the same treatment in 1912. They were sprayed five times with 4-3-50 Bordeaux mixture—once before the blossom, once immediately after the blossom, and the other applications at intervals of about two weeks. Two pounds of rosin-fishoil soap were added to each 50 gallons of Bordeaux mixture in the last two applications.

## RESULTS.

As there was no fruit in 1910 it was, of course, impossible to obtain accurate data as to the effect of the various treatments. There seemed to be less diseased wood in the plats which were treated than in the others. In 1911, counts were made of the sound and diseased berries on 1,000 average bunches of grapes from each control plat, with the results shown in Table I. Much of the young wood in the control plats was injured by the disease. A portion of a vine from one of the control plats is shown in Plate II, figure 2, while a portion of a vine showing the average condition in the treated plats is reproduced in Plate II, figure 1. There was practically no damage from disease in plats Nos. 1, 2, 4, and 5, which were treated before the buds swelled, while in the plats which received only the summer spray there were a few diseased berries and some diseased wood.

The results in 1912 were much the same as in 1911. The amount of diseased fruit on plat No. 3, the control, was not as great as in 1911, according to counts made of the sound and diseased berries on 1,000 average bunches of grapes, owing probably to weather conditions and the pruning out of the diseased wood the previous seasons. Considerable diseased wood was present in the control, as in the season of 1911, and the foliage was somewhat damaged. There was practically no evidence of disease in plats Nos. 1, 2, 4, and 5, which were treated while the vines were dormant. In the plats receiving only the summer treatment with Bordeaux mixture occasional diseased berries and cankered canes could be found. In plat No. 6, which had been treated only one year, the diseased wood and fruit were especially abundant.

Of the different mixtures used, the self-boiled lime-sulphur is perhaps the least promising. It burned the foliage somewhat, and there were more diseased fruit and wood in the plat sprayed with this mixture than in that sprayed with Bordeaux mixture.

The fungicides used in treating the dormant vines all seemed equal in efficiency. For commercial purposes, however, the ease with which the mixture may be prepared must be taken into consideration. From this point of view the concentrated lime-sulphur seems to be best, as it is easily prepared and can be applied with any good sprayer. The iron-sulphate and sulphuric-acid mixture is somewhat more difficult to prepare, and any of the mixtures containing sulphuric acid must be applied by hand unless a sprayer especially adapted to withstand the corrosive action of the sulphuric acid is devised. It would seem, therefore, that the lime-sulphur solution will be most economical for dormant application.

## CONCLUSIONS.

In conclusion, it may be said that anthracnose of the grape was controlled in these experiments by pruning out the diseased wood and applying any one of four different treatments to the dormant vines. The fungicides used successfully on the dormant vines were two concentrations of the iron-sulphate and sulphuric-acid mixture, a 4 per cent solution of sulphuric acid and a concentrated lime-sulphur solution (1–10). A careful pruning out of the diseased wood and treatment with summer sprays of 4–3–50 Bordeaux mixture reduced the damage from disease to practically nothing. In contrast to the results from the treatment the loss from disease on the control plats in 1911 was 32.6 per cent and 12.2 per cent. In 1912 the loss on the control plat was 10 per cent of the fruit. In addition to the diseased fruit, the young shoots and foliage in the controls were considerably injured, while the treated plats were practically undamaged.

In combating anthracnose it would probably be advisable to combine the treatment of the dormant vines with the use of the summer spray, especially since black-rot or downy mildew of the grape is usually present. The following treatment of anthracnose-infected vineyards would then be recommended:

(1) Prune out and burn all diseased wood; (2) spray the dormant vines thoroughly with a concentrated lime-sulphur solution in the proportion of 1 gallon of 32° Baumé test lime-sulphur solution to 9 gallons of water; (3) spray the vineyard thoroughly five times, as in

treating black-rot of the grape, with 4–3–50, 4–2–50, or 3–2–50 Bordeaux mixture, the applications to be as follows: (1) When the shoots are from 8 to 12 inches in length; (2) just before the flower buds open; (3) immediately after the blossoms fall; (4) 10 days to 2 weeks after the third application; and (5) about 10 days to 2 weeks after the fourth application.

Trailers, consisting of lengths of hose with short extension rods attached, so that the nozzles may be manipulated by hand, should be used in the last two applications. The addition of 2 pounds of rosin-fishoil soap to 50 gallons of spray mixture in the last two applications is advisable, as it greatly increases the adhesiveness of the fungicide.

Approved:
James Wilson,
*Secretary of Agriculture.*

Washington, D. C., *October 12, 1912.*

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